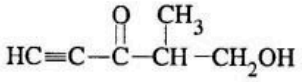
2.1.2 Paper I

1. The number of elements that can exist in liquid state at room temperature (25 °C) and atmospheric pressure (1.0×10^5 N m^{-2}) is,
   (1) 1 (2) 2 (3) 3 (4) 4 (5) 5

2. The correct **increasing** order of atomic radii of C, O, Al, P and Ca is,
   (1) O < C < Al < P < Ca (2) O < C < P < Al < Ca
   (3) C < O < P < Al < Ca (4) C < O < Al < P < Ca
   (5) C < O < Al < Ca < P

3. What is the IUPAC name of the following compound?



   (1) 1-hydroxy-2-methylpent-4-yn-3-one
   (2) 2-methyl-3-oxopent-4-yn-1-ol
   (3) 2-methyl-4-pentyn-1-ol-3-one
   (4) 5-hydroxy-4-methylpent-1-yn-3-one
   (5) 5-hydroxy-4-methyl-1-yne-3-pentanone

4. Which of the following statements is **not** true with regard to elements in the second period from Li to F?
   (1) The highest negative electron affinity is shown by F.
   (2) The highest positive electron affinity is shown by Be.
   (3) The highest oxidation state is exhibited by C.
   (4) Atomic radii decrease from Li to F.
   (5) The ability to form cations and to act as reducing agents decreases from Li to F.

5. The identity of an electron in an atom can be expressed using four quantum numbers (n, l, m_l, m_s). Identify which set of numbers given below is **not** acceptable as a set of quantum numbers for an electron in an atom.
   (1) $\left(4, 2, 0, +\frac{1}{2}\right)$ (2) $\left(3, 1, -1, +\frac{1}{2}\right)$ (3) $\left(3, 2, -3, +\frac{1}{2}\right)$
   (4) $\left(2, 1, 1, +\frac{1}{2}\right)$ (5) $\left(4, 0, 0, -\frac{1}{2}\right)$

6. Which row of the following table gives the correct information with regard to the NSF molecule?

	Oxidation state of S	Charge on S	Hybridization of S	$\hat{NSF}$ bond angle	Nature of S—F bond
(1)	– 4	– 2	sp	180°	S(sp h.o)—F(2p a.o)
(2)	–1	–1	sp^2	< 120°	S(sp^2 h.o)—F(2p a.o)
(3)	0	+1	sp^2	> 120°	S(sp^2 h.o)—F(2p a.o)
(4)	+1	0	sp^3	90°	S(sp^3 h.o)—F(2p a.o)
(5)	+4	0	sp^2	between 90° – 120°	S(sp^2 h.o)—F(2p a.o)

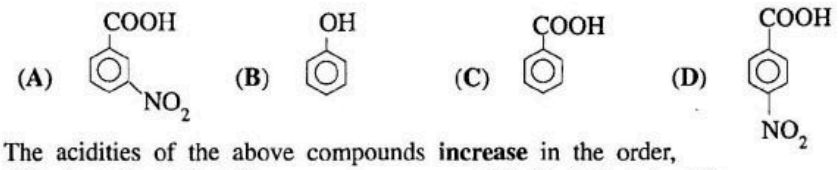
(h.o = hybrid orbital, a.o = atomic orbital)

7. A gaseous hydride of nitrogen, N_aH_b (20 cm^3) was burnt in excess O_2 to give 10 cm^3 of N_2 and 30 cm^3 of water vapour. The formula of the gaseous hydride is,
   (1) NH_3 (2) N_2H_2 (3) N_2H_4 (4) N_3H (5) N_3H_5

8. Thermal decomposition of 15.6 g of a hydrated metal carbonate, $MCO_3 . 4H_2O$ produces 4.0 g of the metal oxide. The relative atomic mass of the metal **M** is, (H = 1, C = 12, O = 16)
   (1) 63.5 (2) 56 (3) 40 (4) 26 (5) 24

9. Choose the molecule that **does not** have a dipole moment.
(1) SF_2 (2) PCl_4F (3) SF_4 (4) PCl_3 (5) SF_6

10. A solution has been prepared by mixing 250 cm^3 of a Na_2SO_4 solution of concentration 0.150 mol dm^{-3} and 750 cm^3 of a NaCl solution of concentration 0.100 mol dm^{-3}. The composition of this solution in terms of ppm Na is, (O = 16, Na = 23, S = 32, Cl = 35.5)
(1) 3450 (2) 2588 (3) 1725 (4) 3.45 (5) 0.15

11. 

The acidities of the above compounds **increase** in the order,
(1) **A < D < B < C** (2) **B < C < A < D** (3) **B < C < D < A**
(4) **C < B < A < D** (5) **D < A < B < C**

12. The IUPAC name of $[Cr(NH_3)_6][Fe(CN)_6]$ is,
(1) Hexaamminechromium(III)ionhexacyanoferrate(II) ion
(2) Hexaamminechromium(III) hexacyanoferrate(II)
(3) Hexaamminechromium(III)hexacyanoferrate(III)
(4) Hexaamminechromium(III) hexacyanoferrate(III)
(5) Hexaamminechromium(II) hexacyanoferrate(II)

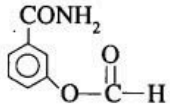
13. $\overset{\mathbf{a}}{CH_3}-\overset{\mathbf{b}}{CH_2}-\overset{\mathbf{c}}{C}\equiv\overset{\mathbf{d}}{C}-\overset{\mathbf{e}}{CH}=CH_2$

Which of the following arrangements gives the correct **increasing** order of the bond lengths of the bonds labelled as **a**, **b**, **c**, **d** and **e** in the above molecule?
(1) **a < b < d < e < c** (2) **c < d < e < b < a** (3) **c < e < d < a < b**
(4) **c < e < d < b < a** (5) **d < c < e < b < a**

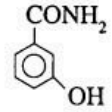
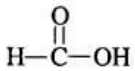
14. Vessel **A** contains helium gas at 27 °C. Vessel **B** contains oxygen gas at 127 °C. The ratio of the root mean square velocities of the gases in vessel **A** and vessel **B**, $\frac{\sqrt{\overline{C_A^2}}}{\sqrt{\overline{C_B^2}}}$ is, (He = 4, O = 16)
(1) 0.4 (2) 1.7 (3) 2.4 (4) 4.9 (5) 25

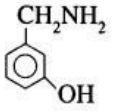
15. (**A**) $CH_3CH_2CH_2CH_2OH$ (**B**) $CH_3CH_2CH_2CH_2Cl$
(**C**) $HOCH_2CH_2CH_2CH_2OH$ (**D**) $CH_3CH_2CH_2CHO$
Which of the following arrangements shows the correct **increasing** order of solubilities of the above compounds in water?
(1) **B < A < D < C** (2) **B < C < D < A** (3) **B < D < A < C**
(4) **C < A < D < B** (5) **D < B < A < C**

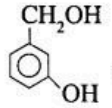
16. Which of the following systems liberates the largest amount of heat upon mixing 1.0 dm^3 of each of the following solutions?
(1) 0.100 mol dm^{-3} HCl and 0.200 mol dm^{-3} NaOH
(2) 0.100 mol dm^{-3} H_2SO_4 and 0.200 mol dm^{-3} NaOH
(3) 0.200 mol dm^{-3} CH_3COOH and 0.200 mol dm^{-3} KOH
(4) 0.400 mol dm^{-3} CH_3COOH and 0.200 mol dm^{-3} KOH
(5) 0.100 mol dm^{-3} HNO_3 and 0.200 mol dm^{-3} NaOH

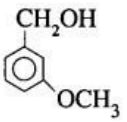
17. 

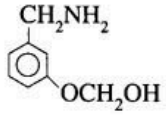
What are the products obtained when the above compound is reacted with $LiAlH_4$ followed by neutralization of the reaction mixture?

(1)  and 

(2)  and CH_3OH

(3)  , CH_3OH and NH_3

(4)  and NH_3

(5) 

- Questions **18** and **19** are based on the following paragraph. Read the paragraph carefully and select the answers for the questions.

When light strikes on certain metal surfaces, electrons can be ejected from it. The energy carried by the photons in light is transferred to electrons in the metal and if an electron acquires sufficient energy to overcome its attractive forces with the positively charged nucleus, it may escape from the surface as a photoelectron. The minimum energy required for the electron to escape varies from one metal to another.

18. The energy required for photoelectrons to be ejected from the surface of barium is 240 kJ per mole of electrons. The minimum frequency of light capable of producing a photoelectron in barium is,
(1) 5×10^{12} s^{-1} (2) 6×10^{12} s^{-1} (3) 2×10^{14} s^{-1} (4) 6×10^{14} s^{-1} (5) 5×10^{15} s^{-1}

19. The maximum wavelength of light that can produce this effect in barium is,
(1) 450 nm (2) 480 nm (3) 500 nm (4) 530 nm (5) 550 nm

20. The molecular shape and electron pair geometry of $XeOF_4$ are respectively,
(1) trigonal bipyramidal and octahedral.
(2) square pyramidal and trigonal bipyramidal.
(3) trigonal bipyramidal and square pyramidal.
(4) square pyramidal and octahedral.
(5) octahedral and square pyramidal.

21. Which one of the following statements is **correct** with regard to elements from Sc to Zn in the Periodic Table and their compounds?
(1) They have lower densities than K and Ca.
(2) Some of them exhibit non-metallic properties.
(3) $Cr_2O_7^{2-}(aq)$ is converted to $CrO_4^{2-}(aq)$ and $Cr^{3+}(aq)$ upon addition of dilute NaOH.
(4) They have electronegativities lower than *s* block elements in the same period.
(5) Mn forms acidic, amphoteric and basic oxides.

22. The standard enthalpies of combustion of C(s), S(s) and $CS_2(l)$ are -394 kJ mol^{-1}, -296 kJ mol^{-1} and -1072 kJ mol^{-1}, respectively. The standard enthalpy of formation of $CS_2(l)$ is,
(1) -86 kJ mol^{-1} (2) 86 kJ mol^{-1} (3) 382 kJ mol^{-1}
(4) -1762 kJ mol^{-1} (5) 1762 kJ mol^{-1}

23. **(A)** $CH_3CH_2CH{=}CH_2$ **(B)** $CH_2{=}CH_2$
(C) $CH_2{=}CH{-}CO_2H$ **(D)** $(CH_3)_2C{=}CH_2$

Which of the following arrangements gives the correct **increasing** order of the reactivities of the above compounds towards HBr?
(1) **B < A < C < D** (2) **B < A < D < C** (3) **C < B < A < D**
(4) **C < D < B < A** (5) **D < A < B < C**

24. Ammoniacal CuCl can be used to distinguish between $CH_3C{\equiv}CH$ and $CH_3CH{=}CH_2$ because,
(1) $CH_3C{\equiv}CH$ is oxidized by CuCl faster than $CH_3CH{=}CH_2$.
(2) $CH_3C{\equiv}CH$ is reduced by CuCl faster than $CH_3CH{=}CH_2$.
(3) $CH_3C{\equiv}CH$ can oxidize Cu^+ to Cu^{2+} while $CH_3CH{=}CH_2$ cannot.
(4) $CH_3C{\equiv}CH$ contains an acidic hydrogen which can be displaced by Cu^+ while $CH_3CH{=}CH_2$ does not.
(5) $CH_3C{\equiv}CH$ undergoes an electrophilic addition reaction with CuCl while $CH_3CH{=}CH_2$ does not.

25. An aqueous saturated solution of $\mathbf{M}(OH)_2$ has a pH of 10.0 at 25 °C. The solubility product of $\mathbf{M}(OH)_2$ at the same temperature is,
(1) 2.0×10^{-30} mol^3 dm^{-9}
(2) 4.0×10^{-30} mol^3 dm^{-9}
(3) 5.0×10^{-13} mol^3 dm^{-9}
(4) 2.0×10^{-12} mol^3 dm^{-9}
(5) 4.0×10^{-12} mol^3 dm^{-9}

26. The correct **decreasing** order of N—O bond distances in NH_2OH, NO, NO_2^- and NO_3^- is,
(1) $NO_2^- > NO_3^- > NO > NH_2OH$
(2) $NO_3^- > NO_2^- > NO > NH_2OH$
(3) $NO > NO_2^- > NO_3^- > NH_2OH$
(4) $NH_2OH > NO_3^- > NO_2^- > NO$
(5) $NO > NO_3^- > NO_2^- > NH_2OH$

27. Which of the following statements is **correct** with regard to the chemistry of Group I and II elements (*s* block elements) and their compounds?
(1) All Group I and II elements react with cold water to give H_2 and their metal hydroxides.
(2) $LiNO_3$ decomposes on heating to give NO_2 and O_2 as gases.
(3) The solubility of Group II sulphates decreases down the group.
(4) The basic strength of Group II hydroxides decreases down the group.
(5) The oxides of Group II elements can be obtained on heating their carbonates.

28. A sample of NaOH is contaminated with an inert impurity. 4.00 g of this NaOH sample was dissolved in 1.0 dm^3 of water, and a 50.0 cm^3 sample of the resulting solution was allowed to react with 50.0 cm^3 of 0.10 mol dm^{-3} HCl solution. The pH of the reaction mixture was found to be 2.0. The percentage purity of the NaOH sample is, (H = 1, O = 16, Na = 23)
(1) 12 (2) 20 (3) 60 (4) 80 (5) 90

29. At room temperature, a solution of 0.10 mol dm^{-3} HCl was slowly added to 100.0 cm^3 of a $Pb(NO_3)_2$ solution until the reaction was complete. The resulting solution was filtered, and the residue was dried to a constant mass. The mass of the dry residue was 0.139 g. The concentration of the $Pb(NO_3)_2$ solution is,
(N = 14, O = 16, Cl = 35.5, Pb = 207)
(1) 1.0×10^{-2} mol dm^{-3}
(2) 8.4×10^{-3} mol dm^{-3}
(3) 5.0×10^{-3} mol dm^{-3}
(4) 4.2×10^{-3} mol dm^{-3}
(5) 5.0×10^{-4} mol dm^{-3}

30. Which of the following compounds gives/give a basic gas on heating?
(**A**) $(NH_4)_2CO_3$ (**B**) NH_4Cl (**C**) NH_4NO_2 (**D**) NH_4NO_3 (**E**) $(NH_4)_2Cr_2O_7$
(1) **A** only. (2) **B** only. (3) **E** only. (4) **A** and **B** only. (5) **C** and **D** only.

● For each of the questions **31** to **40**, one or more responses out of the four responses (*a*), (*b*), (*c*) and (*d*) given is/are correct. Select the correct response/responses. In accordance with the instructions given on your answer sheet, mark

(1) if only (*a*) and (*b*) are correct.
(2) if only (*b*) and (*c*) are correct.
(3) if only (*c*) and (*d*) are correct.
(4) if only (*d*) and (*a*) are correct.
(5) if **any other** number or combination of responses is correct.

Summary of above Instructions

(1)	(2)	(3)	(4)	(5)
Only (*a*) and (*b*) are correct	Only (*b*) and (*c*) are correct	Only (*c*) and (*d*) are correct	Only (*d*) and (*a*) are correct	**Any other** number or combination of responses is correct

31. Which of the following statements is/are **true** regarding electrochemical reactions and electrode potentials?
(*a*) Electrode potential is an intensive property.
(*b*) Half-cell reactions are reversible.
(*c*) Standard electrode potential changes its sign (+ or –) for the reverse reaction.
(*d*) Electrode potentials are independent of the temperature.

32. Which of the following statements is/are **true** regarding compound **A**?

(A) $HC{\equiv}C{-}CH_2CH_2CH_2NH_2$

(*a*) **A** forms an aldehyde upon treatment with dil. H_2SO_4 in the presence of $HgCl_2$.
(*b*) **A** liberates H_2 when reacted with sodium.
(*c*) **A** liberates N_2 when reacted with $NaNO_2$/aq. HCl.
(*d*) **A** liberates CO_2 when treated with aq. $NaHCO_3$.

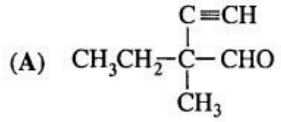
33. Which of the following statements is/are **true** regarding the polymers, polystyrene, polyvinylchloride, phenol-formaldelyde and nylon?
(*a*) Only polystyrene and polyvinylchloride are thermoplastic polymers.
(*b*) Only polystyrene, polyvinylchloride and nylon are thermosetting polymers.
(*c*) Only phenol-formaldehyde and nylon are prepared by condensation polymerization.
(*d*) Only polystyrene, polyvinylchloride and nylon are prepared by condensation polymerization.

34. Which of the following statement is/are **true** regarding natural rubber?
(*a*) The relative molecular mass of natural rubber is around 750 000.
(*b*) Ebonite is formed when natural rubber is heated with a large amount of sulphur.
(*c*) Although *cis* and *trans* isomers are possible in natural rubber due to the presence of double bonds, natural rubber has a *trans* configuration.
(*d*) Vulcanization of natural rubber reduces its hardness.

35. An ideal solution is prepared by mixing two miscible pure liquids. Which of the following statements is/are **true** regarding the above?
(*a*) The enthalpy change during mixing is zero.
(*b*) Raoult's Law cannot be applied to the above ideal solution.
(*c*) The vapour pressure of the solution is equal to the sum of the partial pressures of the two liquids.
(*d*) The vapour pressure of the solution varies linearly with the mole fraction of each of the liquids.

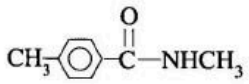
36.

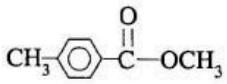
(A)

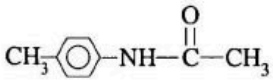


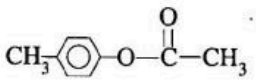
When one of the enantiomers of **A**,
(*a*) is treated with Zn(Hg)/conc. HCl, the product does not show optical activiy.
(*b*) is treated with $LiAlH_4$, the product does not show optical activity.
(*c*) is treated with ammoniacal $AgNO_3$, the product does not show optical activity.
(*d*) is treated with H_2/Pd, the product does not show optical activity.

37. Compound **B** was heated with aq. NaOH and the cooled reaction mixture was neutralized. When bromine water was added to the reaction mixture, it was decolorized. According to this observation, which of the following compounds could be **B**?

(*a*) 

(*b*) 

(*c*) 

(*d*) 

38. Which of the following statements is/are **true** regarding equilibrium systems?
   (*a*) The unit of the equilibrium constant of a chemical reaction can be deduced from the balanced chemical equation.
   (*b*) Equilibrium constants of both exothermic and endothermic reactions change with temperature.
   (*c*) Both gas phase and liquid phase chemical reactions can reach equilibrium in open systems.
   (*d*) If an equilibrium reaction can be expressed as the sum of two or more equilibrium reactions, the equilibrium constant for the overall reaction is given by the sum of the equilibrium constants of the individual reactions.

39. Which of the following statements is/are **true** regarding NH_3?
   (*a*) NH_3 can act as both an oxidizing agent and a reducing agent.
   (*b*) NH_3 is produced in large scale using the Haber process which employs N_2 and H_2 under high pressures and high temperatures.
   (*c*) When NH_3 reacts with excess Cl_2 gas, the products are N_2O and HCl.
   (*d*) NH_3 is used in the rubber industry to prevent premature coagulation of latex.

40. The only Group IA element to react with nitrogen gas is Li. In an experiment, 51 g of Li is allowed to react with 39 g of N_2. Which of the following statements is/are **true**? (Li = 7, N = 14)
   (*a*) Li will react completely and some N_2 will remain.
   (*b*) N_2 will react completely and some Li will remain.
   (*c*) Neither Li nor N_2 will react completely.
   (*d*) Theoretically, the amount of product formed will be 85 g.

● In questions No. **41** to **50**, two statements are given in respect of each question.
From the Table given below, select the response out of the responses (1), (2), (3), (4) and (5) that **best** fits the two statements and mark appropriately on your answer sheet.

Response	First Statement	Second Statement
(1)	True	True, and correctly explains the first statement.
(2)	True	True, but does **not** explain the first statement correctly.
(3)	True	False
(4)	False	True
(5)	False	False

	First Statement	Second Statement
41.	NH_3 acts as a Lewis base, while BF_3 acts as a Lewis acid.	A Lewis base accepts protons, while a Lewis acid donates protons.
42.	The two N—O bond lengths in NO_2Cl are equal.	Two acceptable stable resonance structures can be drawn for NO_2Cl.
43.	The boiling point of butanoic acid is higher than the boiling point of 1-butanol.	No hydrogen bonds are present in 1-butanol.
44.	Enthalpy of mixing of an ideal solution is zero.	Attraction forces amongst different types of molecules and attraction forces amongst the same types of molecules are equal in an ideal solution.

45.	All three carbon atoms in propenal lie on one straight line.	All three carbon atoms in propenal are *sp* hybridized.
46.	Contribution to photochemical smog cannot be reduced by attaching catalytic converters to the tail pipes of vehicles.	In a catalytic converter, carbon monoxide and partially combusted hydrocarbons are oxidized to CO_2, and nitrogen oxides are reduced to N_2.
47.	The order of the reaction, $2N_2O_5(g) \xrightarrow{\Delta} 4NO_2(g) + O_2(g)$ can be determined by monitoring the volume change of the system with time when a sample of $N_2O_5(g)$ is heated.	The order of a chemical reaction with respect to a reactant does not depend on the concentration of the reactant.
48.	H_2S found in petroleum deposits is used in the large scale manufacture of sulphur.	Large underground deposits are the principal sources of elemental sulphur.
49.	If a yellow precipitate forms when $Pb(NO_3)_2$ solution is added to an aqueous solution, the only possible conclusion is that I^- ions are present.	The only water insoluble yellowish compound that Pb forms is PbI_2.
50.	Hydrochlorofluorocarbons are used as an alternative for chlorofluorocarbons to protect the ozone layer.	Hydrochlorofluorocarbons are not harmful to the ozone layer.

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